

Portable Testbed to measure QoS & QoE metrics on IP Networks (IPv4 & IPv6)

Version 5.0

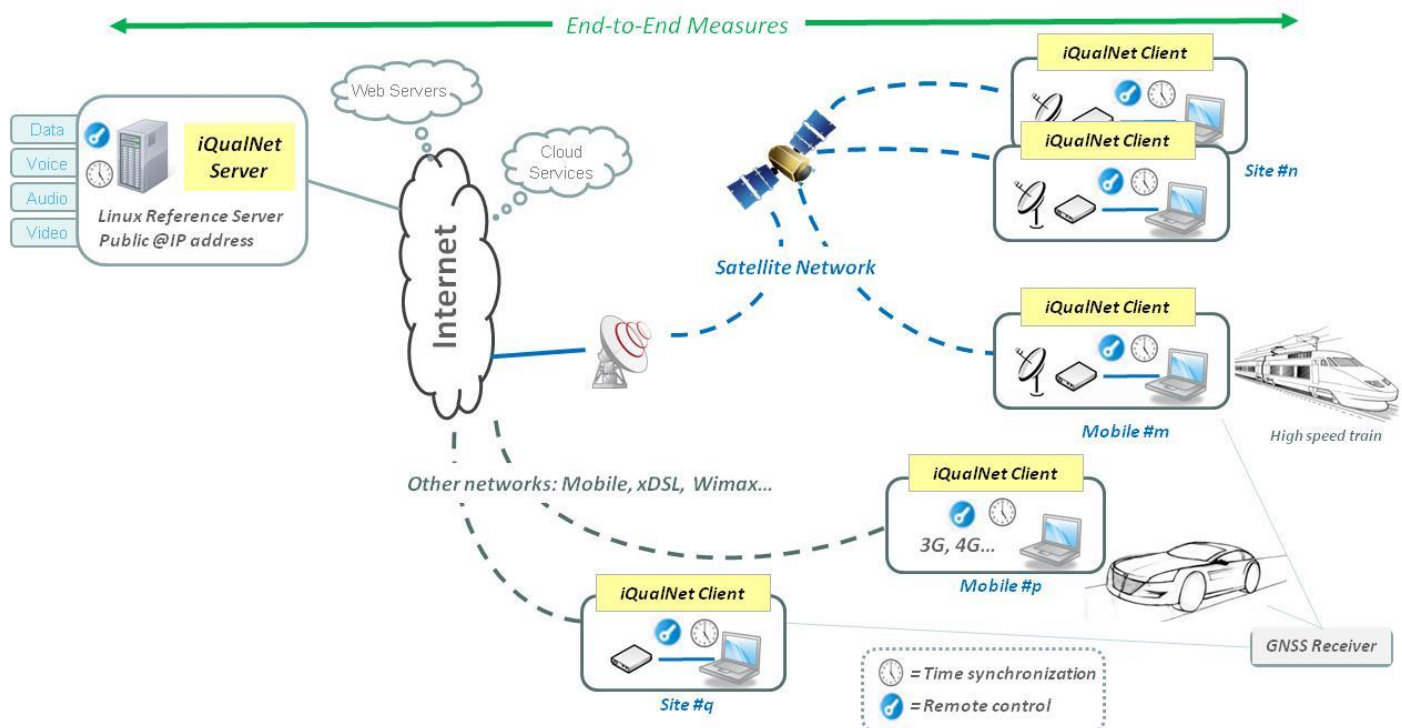
Contents

1.	Product Overview	2
1.1	Product Requirements	2
1.2	Examples of Use Cases	3
1.3	Key Features	4
1.4	Patented Technology.....	4
2.	Product Description	5
1.5	The Test Campaign Manager	6
1.6	Services and Profiles for the Test Campaign	9
1.7	Key Metrics	11
1.8	Post-processing	12
1.9	iQualNet Client: Master & Slave stations.....	18
3.	Conditions of use	19
4.	Delivery	19
5.	For more information	19
6.	Annex: Glossary of Terms	20

Revision 1.8

1. Product Overview

The **iQualNet** software is a QoS (Quality of Service) and QoE (Quality of Experience) measurement tool for IPv4 and IPv6 networks. This tool runs on Windows platform clients and can be used for measurement on any type of IP network: fixed, mobile, satellite, WiFi, PLC and more... To measure **End-to-End** QoS and QoE parameters, **iQualNet** uses **real applications** and a **reference server** as shown in the diagram below. **iQualNet** generates real traffic, not simulated or emulated traffic.



One or more **iQualNet** clients dialog via the Internet with the iQualNet reference server or other external servers by using the access network to characterize. The use of the reference server ensures the availability of services used by a remote **iQualNet** client on a site and to guarantee adequate bandwidth for tests realized (resource reservation is made by the server for testing from an **iQualNet** remote station). Thus, only the network metrics are characterized and the client or the server adds no uncertainty.

Product Requirements



- * Platform running 32-bit or 64-bit version of Windows XP^(32-bit only), Vista, Seven, 8, Server 2003, 2008 or 2012 with Microsoft TCP/IP installed and at least 1 GB Ram. 310 MB free hard disk space.
- * Hyper-threading, multi core and PC multiprocessors are also supported.

- * Display resolution: at least 1024 x 768 (more readable: 1920 x 1080 and sup.), DPI setting = Normal size (96 DPI) and Font Size = Normal.

Examples of Use Cases

The examples below illustrate different use cases with **iQualNet** testbed.

Generally a Windows laptop with iQualNet software is used at the client site.

Test & Measurement campaigns for QoS testing on access to the Internet by satellite coupled Wi-Fi in high-speed trains.

Customer: SNCF (French National Railways)



Campaign performance metrics for the Internet access by satellite for the choice of the satellite network operator (comparison of two service providers). Fixed stations in Burkina Faso.

Customer: European Commission

Measurement campaigns (fixed and mobile) for the performance evaluation of DVB-RCS-S2 terminals and gateways.

Customer: French Space Agency



Test campaigns for measuring the performance of the Internet access by satellite (Ka-band / Ku-band) for the evaluation and comparison of commercial offers.

Customer: French Space Agency

Test campaigns for measuring the performance of access for telecom crisis terminals (Inmarsat BGAN terminal, SCPS protocols...)

Customer: French Space Agency



Key Features

iQualNet software + Windows Laptop = Portable Testbed to measure QoS & QoE on IP Networks

- QoS & QoE Measurements on IP Networks: xDSL, mobile, satellite, WiFi, Wimax... by creating the behavior of N x real concurrent users.
- **Programmable & Periodic** test campaigns / multi-Clients / multi-Sites (fixed or mobile) with optional real-time geolocation by use of GNSS receiver for in-service quality monitoring.
- One **iQualNet** Client = multiple users & multiple real applications (data, voice, audio, video).
- Automated test campaigns implementing real applications (services) that can be structured according to usage profiles configured by the user.
- **End-to-End** QoS and QoE metrics for data, voice, audio & video.
- **Multi-point** testing solution with remote control.
- Ideal for testing multi-Telco's commercial offers.
- Time synchronization with the optional use of a GNSS receiver & Remote control.
- Results per campaign: detailed graphs & statistical values.
- Synthesis report with key quality metrics.
- Accuracy = **1 millisecond resolution**.

***Measuring End-to-End quality & performance of the network
with real applications & simultaneous multi-users
for in-service quality monitoring***

Patented Technology

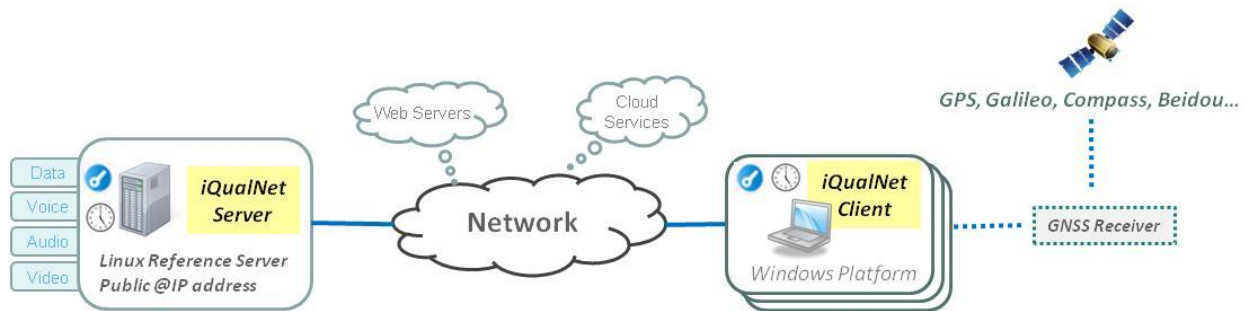
Technology used in this product has been patented by **CNES** (Centre National d'Etudes Spatiales) the **French Space Agency** and this product is marketed under CNES license.

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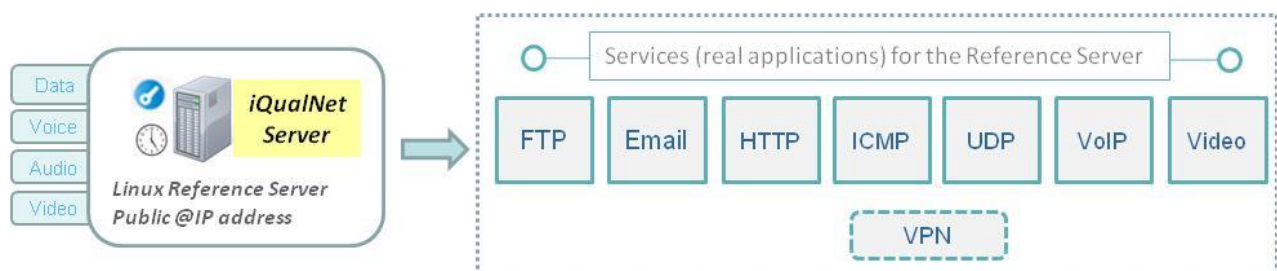
2. Product Description



iQualNet clients (with or without a GNSS receiver) execute test campaigns to measure QoS and QoE metrics with real applications using the **iQualNet** reference server or other external services (Web servers, cloud services...).

Each **iQualNet** client can simulate many end-users, each end-user having different usages.

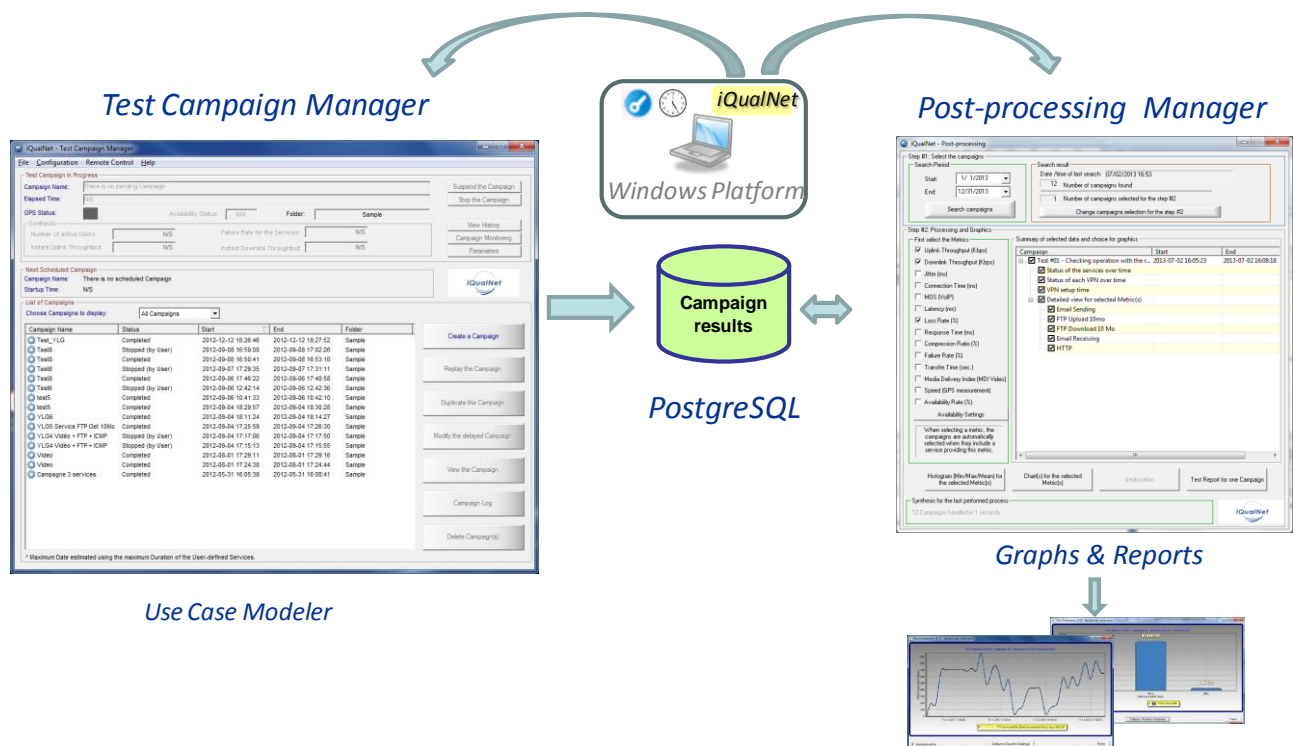
iQualNet reference server is based on Linux Ubuntu platform and has a public @IP address if connected to the Internet. For testing on a private network, **iQualNet** server can be set with a private @IP address. **iQualNet** software server is provided free of charge by ZTI Communications with the purchase of one client license.



To evaluate and try **iQualNet** software, ZTI Communications offers a test reference server hosted in France.

Please contact ZTI Communications sales (sales@zti-communications.com) for more information for testing with the reference server.

iQualNet client software is composed of two modules and uses a PostgreSQL database to save the measurement results.



Two modules for two main processes:

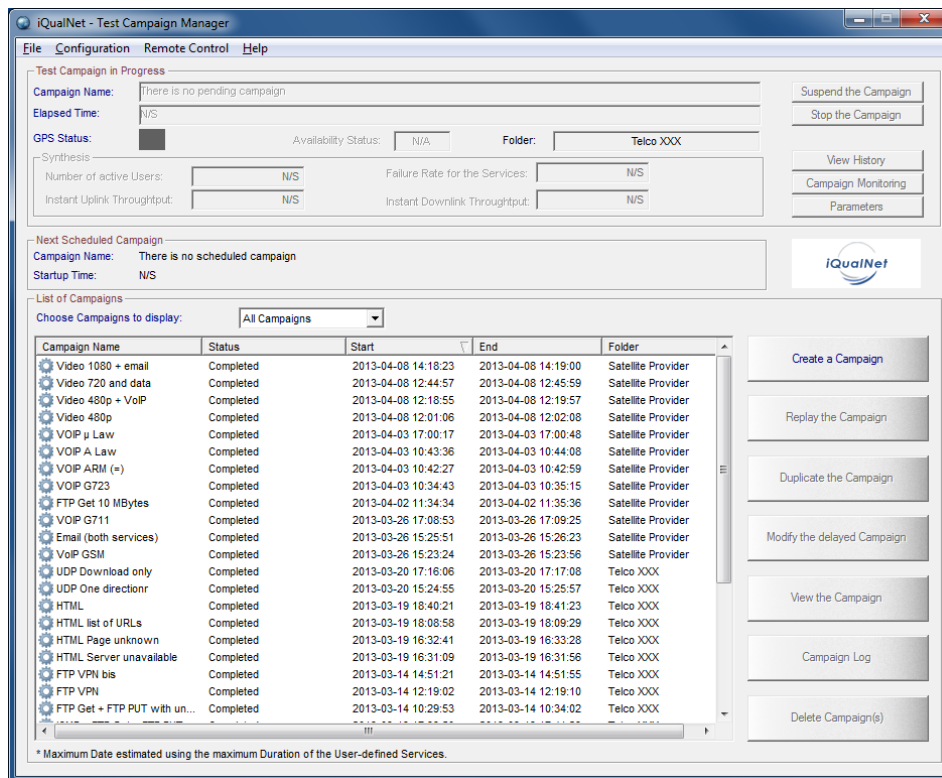
- First module: the **Test Campaign Manager** allows definition of the test campaign content and executes the test campaigns defined by the user. The raw measurement results are saved in the database during the run of the test campaign.
- Second module: the **Post-processing Manager** uses the raw results to calculate the metrics and the graphs desired by the user. A test report summarizes the test results for a campaign.

When a GNSS receiver (GNSS = Global Navigation Satellite System) is used with the station running **iQualNet** software, geolocation and precise timing information is available allowing users to correlate the measurement results with the speed and the position. This feature is particularly useful when you need to do measurements in mobility (e.g. train, car...) and analyze the results depending on the position and the speed.

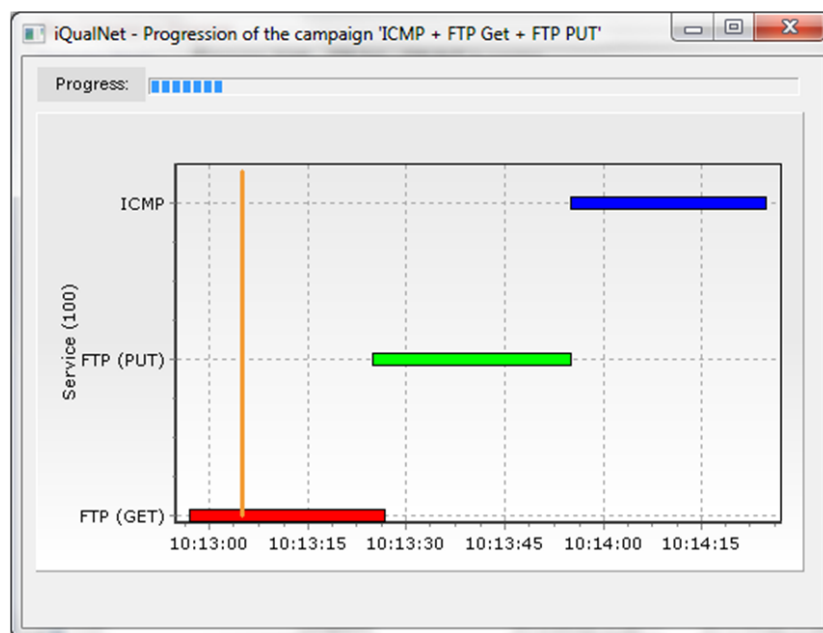
The Test Campaign Manager

The main window of the Test Campaign Manager allows the creation and management of the test campaigns, and gives an overview of the test campaign in progress.

A real-time synthesis and monitoring window is offered during execution of the test campaign and the user can suspend or stop the campaign when needed.

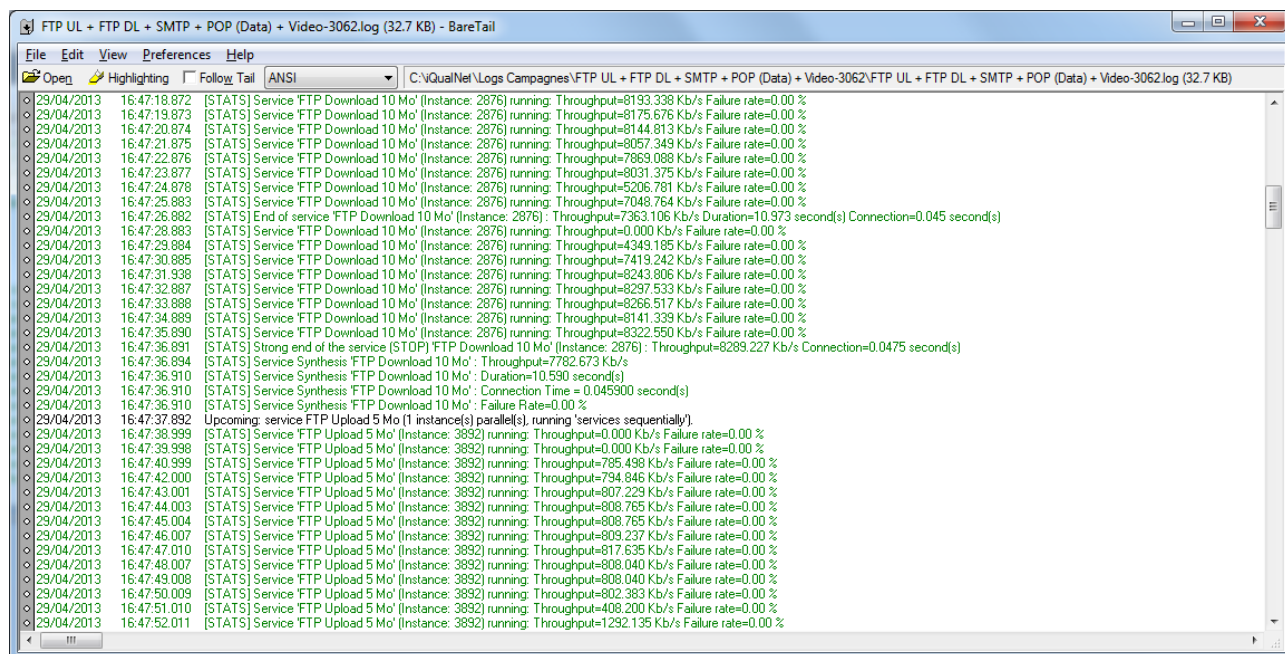


The screenshot below illustrates the window monitoring for a test campaign composed of 3 services within a sequential run.



Window monitoring for test campaign progress

A detailed historic log is also available if needed with timestamping of all events occurred during the campaign.



Example of log for test campaign in progress

The Test Campaign Manager displays a dashboard showing all of the test campaigns already completed and those configured to run in future.

List of functions available for the campaigns management:

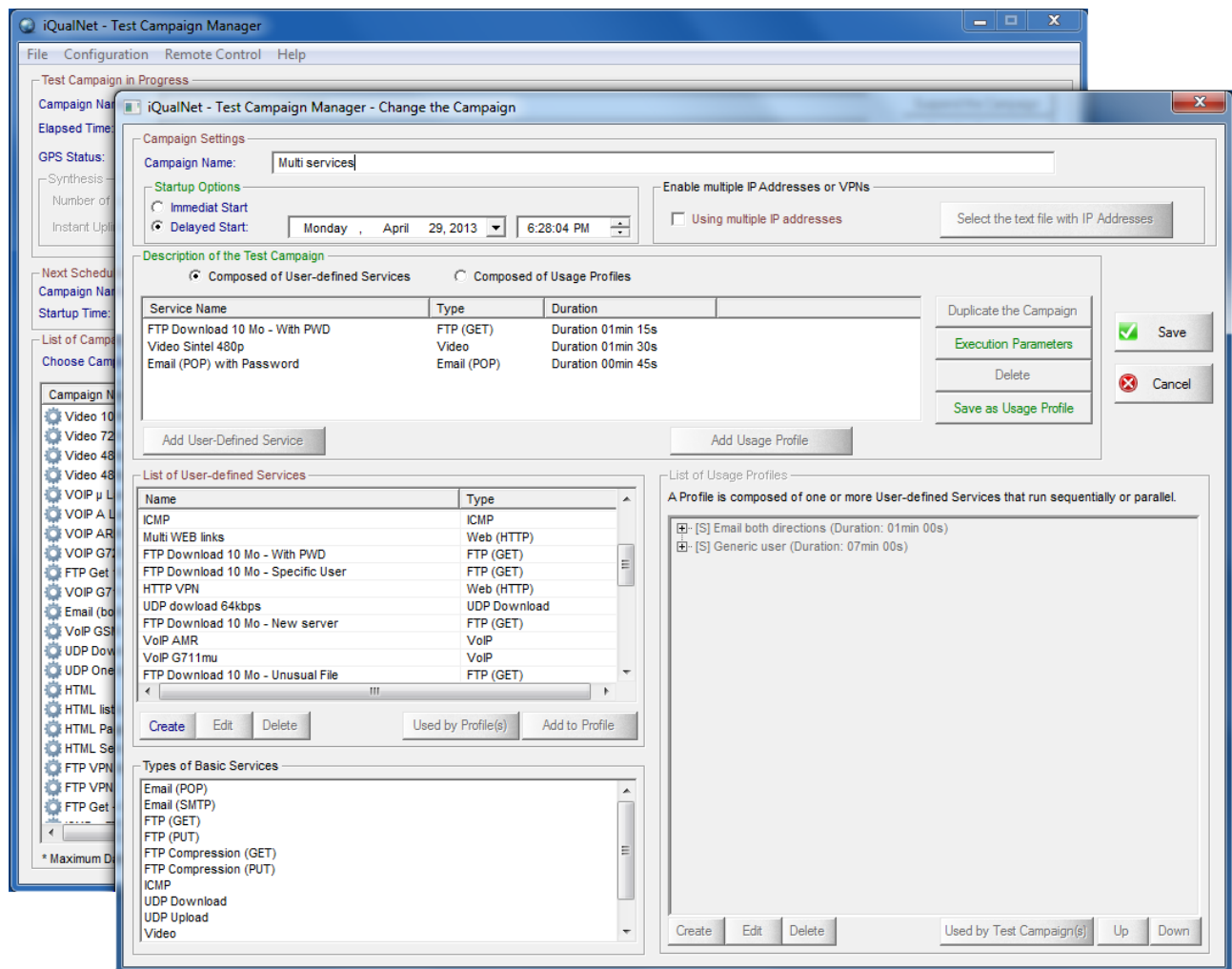
- Create a test campaign
- Replay immediately a test campaign already completed
- Duplicate a test campaign already completed after modification of some settings and definition of a new starting date/time
- Modify a delayed test campaign (change settings and starting date/time)
- View the settings of the test campaign (completed or not)
- Display the campaign log (show execution details of a completed campaign)
- Delete one or several test campaigns (completed or not)

The user can configure if needed a special feature: **Testing for Availability**.

Testing for availability launches periodic ping requests towards the remote (for example: satellite gateway, server ...) in order to check if the communication link is active. The availability test is independent of the campaigns. The results are stored in the database and correlation may be done with the campaign results or not.

Services and Profiles for the Test Campaign

To create a new test campaign, the user has to define campaign settings and contents description.

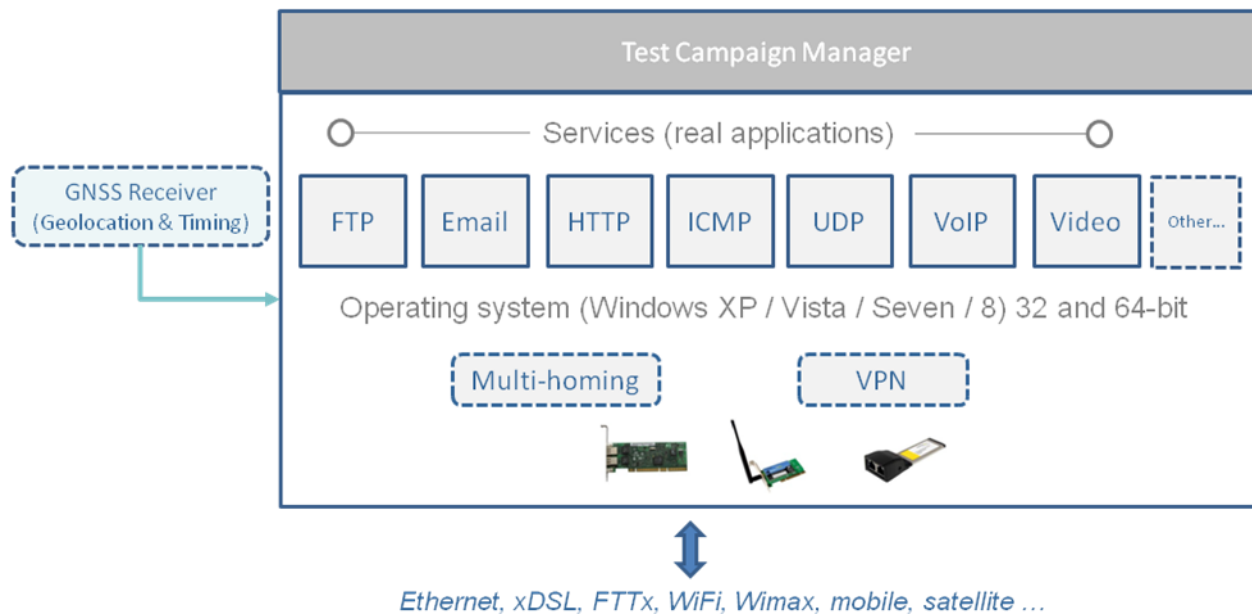


Campaign settings:

- Campaign name
- Startup options:
 - Immediate Start
 - Delayed Start (date & time)
 - Periodic Start (date & time & frequency & duration)
- Use of multiple IP addresses or VPNs

Thus for example, you can program a test campaign running each hour (with a fixed or random starting time in the hour) during 24 hours and for an important number of days. This feature is particularly useful to measure the quality over time for a very long duration.

Several basic **services** (real applications) can be used during a test campaign as shown overleaf, and services can be aggregated in **profiles** (a profile is a class of usage defined by the user e.g. home user, professional, student and more...).

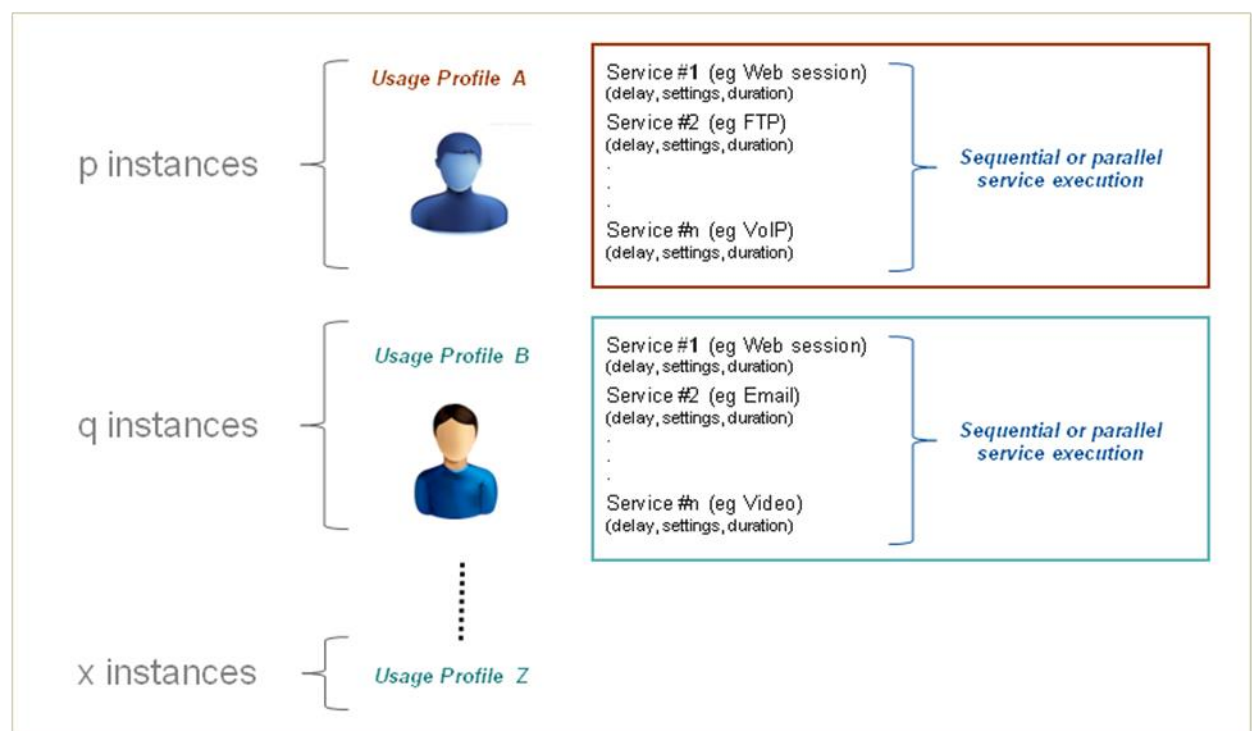


The use of an optional GNSS receiver allows precise synchronization and geolocation measurements (useful if mobile client) for the campaign.

The Test Campaign Manager allows the creation of a campaign composed of either:

- Multiple services
- Multiple profiles

1 test campaign	= { N Services M Profiles } + Starting time [immediate delayed periodic]
1 Service	= 1 application (+ settings) / duration
1 Profile	= multiple services (sequential or parallel) / duration per service / offset time



Examples of usage profiles with different parameters

With a laptop, you can easily simulate up to 20 simultaneous users, each user running multiple services (sequential or parallel). The technical characteristics of the laptop and the network throughput only limit the number of services running in parallel - for example up to 40 video flows (352*288 MPEG-1/2 video) with a laptop using an i5 processor.

Key Metrics

iQualNet calculates metrics for each service performed during a campaign, and the table below summarizes the calculated metrics.

Service	Throughput	Failure rate	Connection time	Transfer duration	Response time	Loss rate	Compression ratio	Jitter	Transit delay	MOS	MDI
HTTP	X	X	X		X						
FTP (GET & PUT) w/ & w/o compression	X	X	X	X			X				
Email (SMTP & POP)	X	X	X		X						
ICMP					X	X					
UDP (Upload & Download)	X	X				X		X	X		
VoIP		X				X		X	X	X	
Video	X	X				X					X
VPN		X (disconnect)	X								

Other parameters independent of the services: Speed (if GNSS receiver present) and Availability ratio (if availability testing activated)

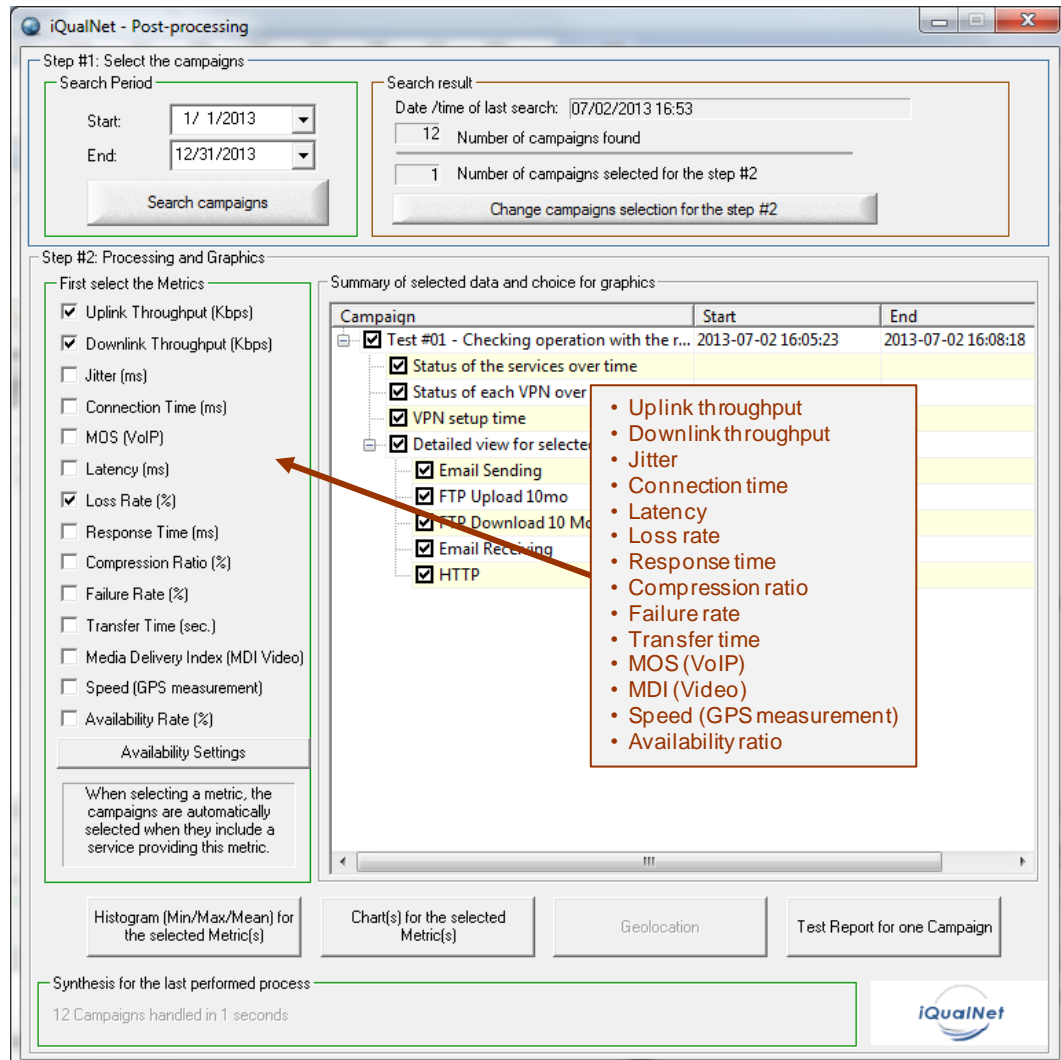
List of ITU standards and RFCs used by **iQualNet** to calculate the metrics:

- ITU G.1010, G.1020, G.1030, G.1040, G.1050, Y.1540, Y.1541, E.107
- RFC 2330, 2678, 2679, 2680, 4445

Post-processing

The execution of test campaigns generates many raw measurements for calculation of the required quality metrics.

The key quality metrics offered by **iQualNet** are presented below:



The user first selects one or more completed campaigns with a set of metrics to calculate.

Using these parameters, **iQualNet** Post-processing is able to display:

- An histogram with the Min, Max and Mean values for each selected metric
- Graphs showing the variation of each metric over time

Results can be exported in several formats: Text, XML, HTML and Excel.

A test campaign report with all the measurement results can be automatically generated: this report first presents an overall synthesis of the results and charts for each metric over the time.

An extract from the final report is presented overleaf as an example for a test campaign that lasted more than 10 hours.

Examples of Test Report generated by the Post-Processing unit.

Example #1: Test all services with sequential execution

iQualNet - Synthesis Report

Campaign name: Test #02 - All Services (short)

Start date: 2013-07-16 21:20:15

End date: 2013-07-16 21:26:10

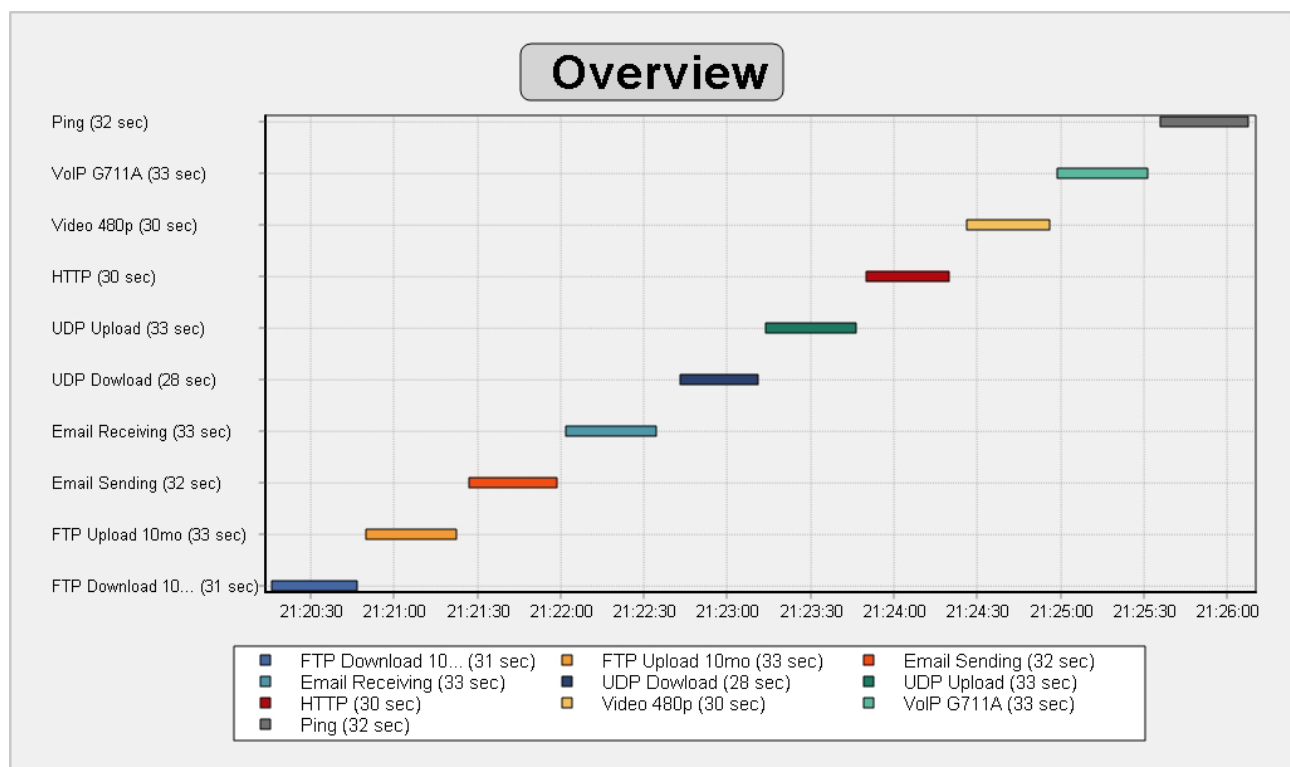
Duration (HH:MM:SS): 00:05:55

Software version: 5.0.2.161

Date of report generation: 2013-09-09 10:40:56

GNSS Receiver: Not Present

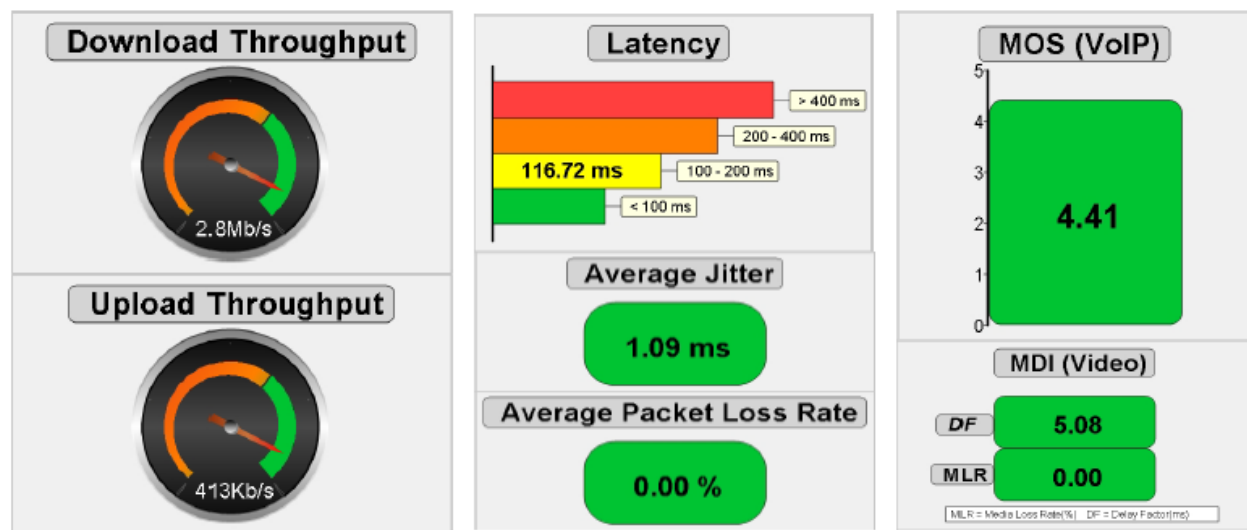
Campaign Description:



Campaign Details:

Service(s)	Duration
[Continuous] FTP Download 10 Mo (FTP (GET))	30 sec
[Continuous] FTP Upload 10mo (FTP (PUT))	30 sec
[Continuous] Email Sending (Email (SMTP))	30 sec
[Continuous] Email Receiving (Email (POP))	30 sec
[Continuous] UDP Dowload (UDP Download)	30 sec
[Continuous] UDP Upload (UDP Upload)	30 sec
[Continuous] HTTP (Web (HTTP))	30 sec
[Continuous] Video 480p (Video)	30 sec
[Continuous] VoIP G711A (VoIP)	30 sec
[Continuous] Ping (ICMP)	30 sec

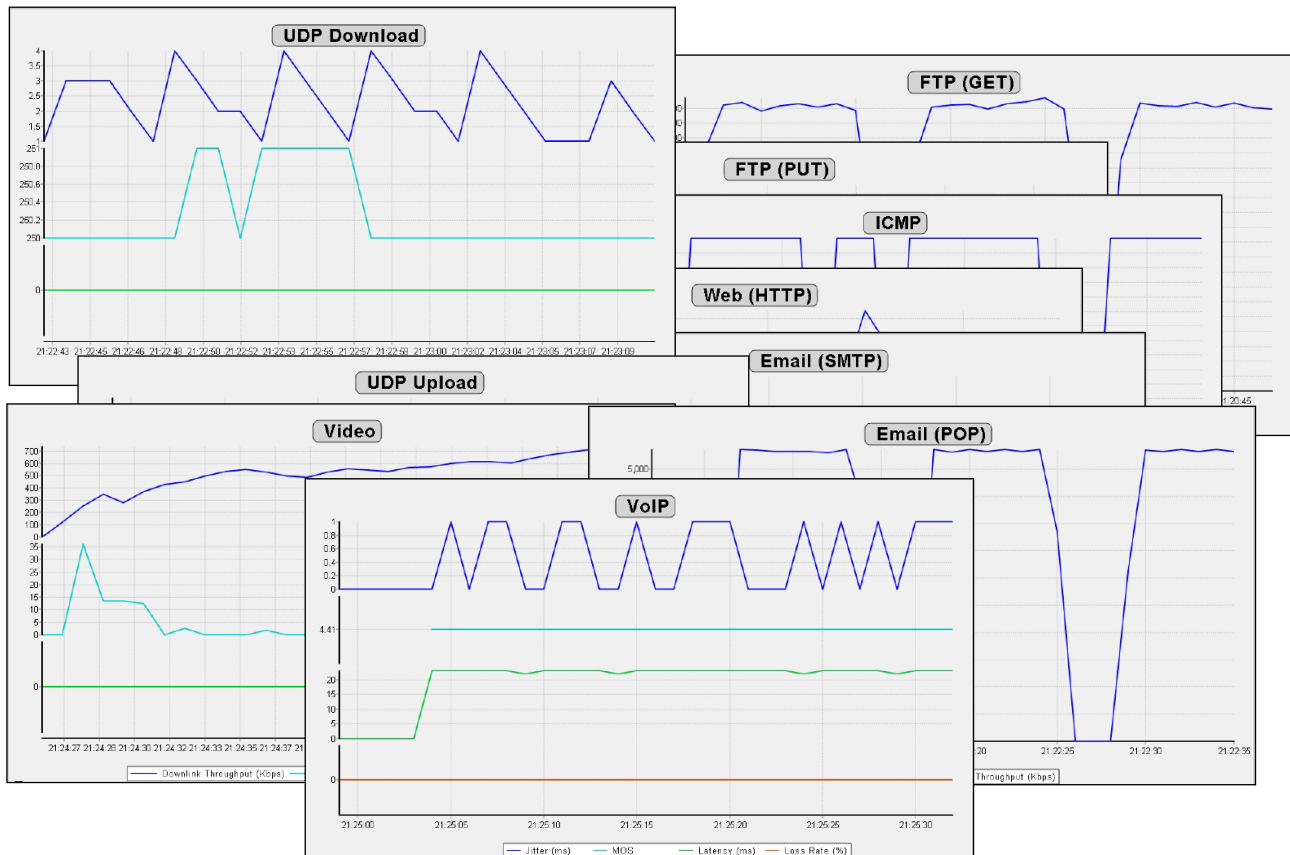
Synthesis



Key Performance Indicators			
FTP Download	9.46 Mb/s	Average Jitter	1.09 ms
FTP Upload	913.71 Kb/s	Average Latency	116.72 ms
HTTP	74.26 Kb/s	Connection Time	0.04 s
HTTPS	N/A	Transfer Time	8.54 s
POP3	3.57 Mb/s	Average Loss Rate	0.00 %
SMTP	0.00 Kb/s	Failure Rate	5.61 %
UDP Download	129.00 Kb/s	Availability Ratio	98.59 %
UDP Upload	326.25 Kb/s	Speed (GPS Measurement)	98.59 %
ICMP	45.0 ms		
VoIP (MOS)	4.41		
Video (MDI) (DF:MLR)	5.08:0.00		

N/A means not available for this campaign

Charts (some examples from the report)



Example #2: Test two profiles with parallel service execution

iQualNet - Synthesis Report

Campaign name: Test #06 - Multi-profiles (parallel)

Start date: 2013-09-09 11:39:37

End date: 2013-09-09 11:41:20

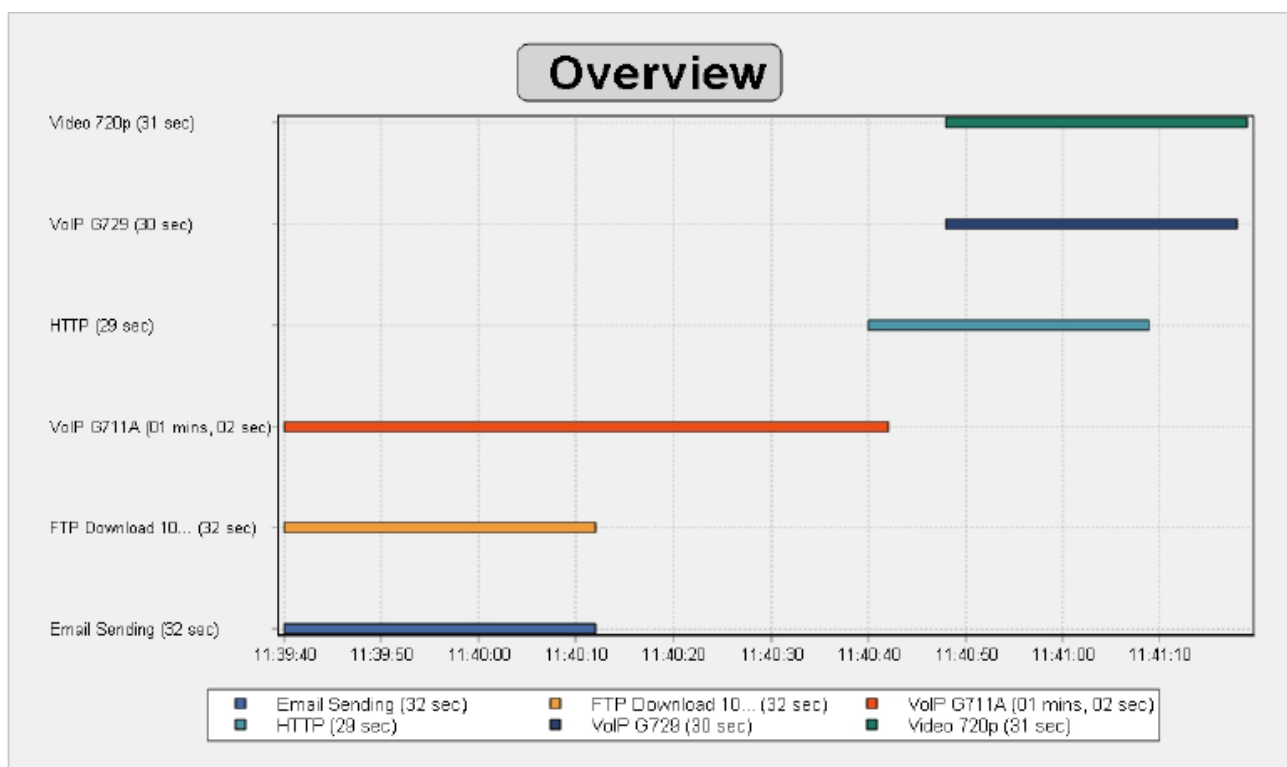
Duration (HH:MM:SS): 00:01:43

Software version: 5.0.3.163

Date of report generation: 2013-09-10 11:15:51

GNSS Receiver: Not Present

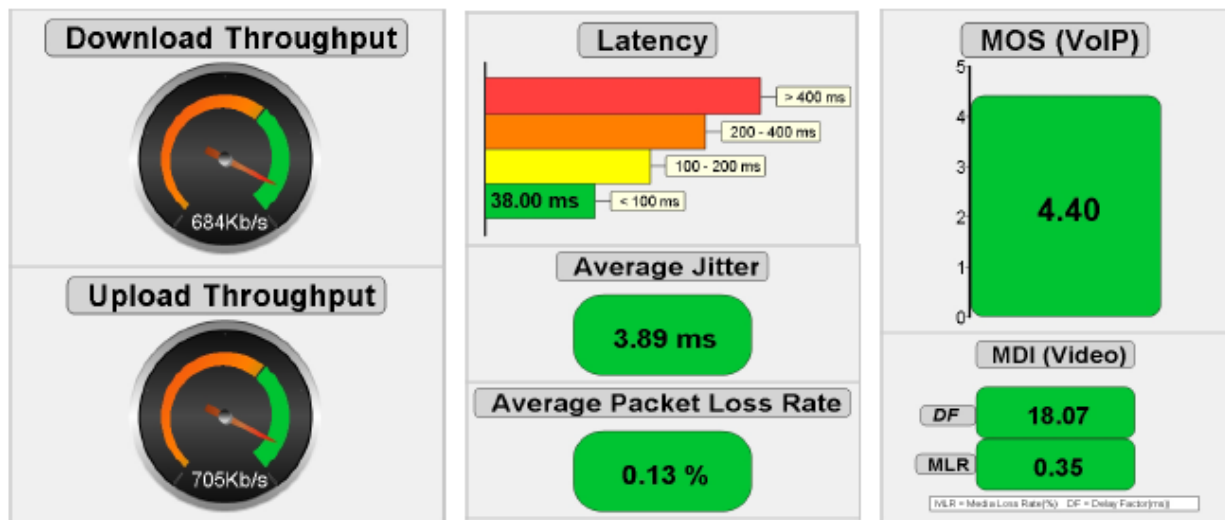
Campaign Description:



Campaign Details:

Profile(s)	Duration	Instance(s)
[Parallel] Business Profile Parrallel	01 mins, 00 sec	1
[Continuous] FTP Download 10 M... (FTP (GET))	30 sec	
[Continuous] Email Sending (Email (SMTP))	30 sec	
[Continuous] VoIP G711A (VoIP)	01 mins, 00 sec	
[Parallel] Home Profile Parrallel	01 mins, 00 sec	1
[Continuous] HTTP (Web (HTTP))	30 sec	
[Continuous] Email Receiving (Email (POP))	30 sec	
[Continuous] VoIP G729 (VoIP)	30 sec	
[Continuous] Video 720p (Video)	01 mins, 00 sec	

Synthesis

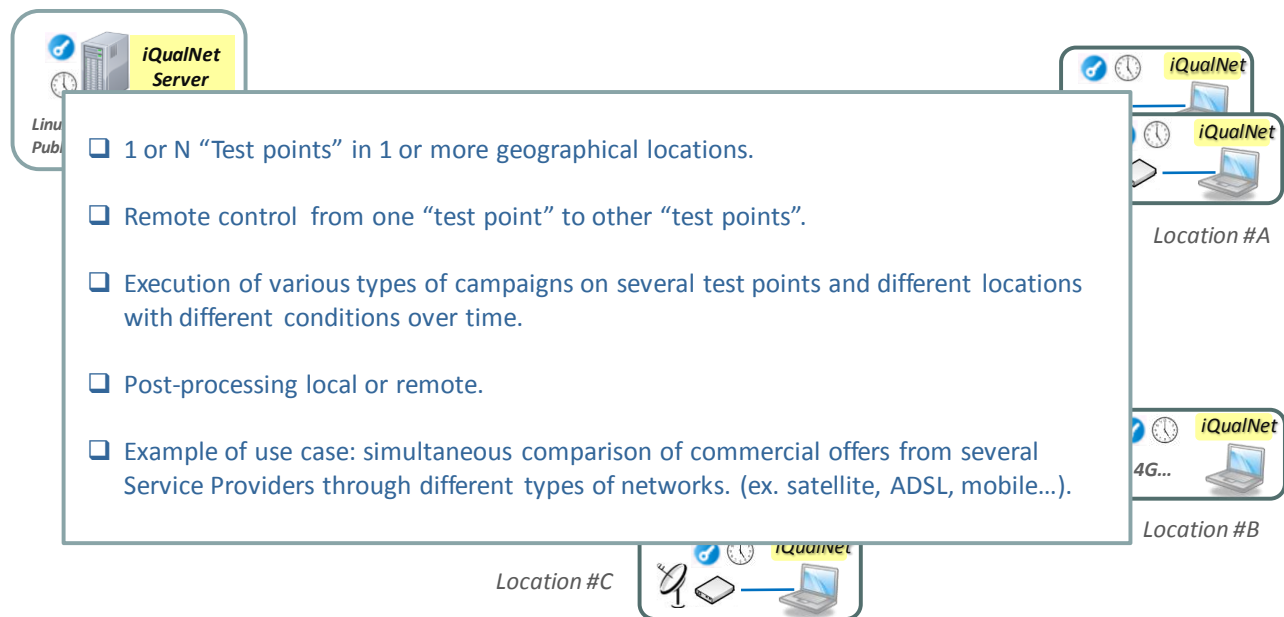


Key Performance Indicators			
FTP Download	1.31 Mb/s	Average Jitter	3.89 ms
FTP Upload	N/A	Average Latency	38.00 ms
HTTP	28.50 Kb/s	Connection Time	0.02 s
HTTPS	N/A	Transfer Time	0.00 s
POP3	N/A	Average Loss Rate	0.13 %
SMTP	704.97 Kb/s	Failure Rate	0.00 %
UDP Download	N/A	Availability Ratio	N/A
UDP Upload	N/A	Speed (GPS Measurement)	N/A
ICMP	N/A		
VoIP (MOS)	4.40		
Video (MDI) (DF:MLR)	18.07:0.35		

N/A means not available for this campaign

The complete report details each completed service (graphics not reproduced here).

iQualNet Client: Master & Slave stations



iQualNet Client can be deployed in one or more geographical locations for test purposes.

The user can set a client in one of the three available operating modes:

- Stand-alone station
- Master station
- Slave station

Remote control is possible between one Master station and multiple Slave stations. The Master station can pilot several Slave stations and offers the following features:

- Transfer test campaigns towards a slave station
- Stop all campaigns (in progress & future)

The Master station needs only to know the IP addresses of the Slave stations (each slave station must authorize the IP access from the Master station).

This authorizes the execution of various types of campaigns on several test points in different locations with different conditions over time.

Post-processing can then be done from a Master or stand-alone station.

3. Conditions of use

iQualNet client software is licensed on a per workstation basis.

You can install **iQualNet** on several PCs, but you need a valid license for each PC where you want to use it which is achieved through the use of a software key or connection of a USB license key.

4. Delivery

The delivery includes one CD-ROM with printed installation guide and one software key or USB Software Protection Key (dongle) per license (depending on the choice at time of purchase).

Technical support and software maintenance (including software updates and upgrades) for a period of twelve months is included in the cost of the first license and it is recommended that this is maintained and purchased for subsequent licenses.

5. For more information

Please contact ZTI Communications sales:

Tel +33 2 9648 4343

Email sales@zti-communications.com

or email the technical support for a prompt reply: support@zti-communications.com

To download the iQualNet trial version, please visit us at www.zti-communications.com
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6. Annex: Glossary of Terms

Bandwidth Throttling

Bandwidth throttling is used for two main purposes:

- Quantify network resources - by evaluating the application's bandwidth requirements, network managers can determine in advance the amount of bandwidth to purchase.
- Evaluate QoS mechanisms - prior to a decision on which QoS mechanism is appropriate for the enterprise, network managers can emulate different Service Level Agreements and evaluate the ROI of different services such as Frame Relay, Diffserv etc.

Delay jitter

Delay variation of the packet transfer caused by the queuing and access delays in the source node, all transit node delays, and the receive buffer delay in the destination node.

Jitter or Inter-Packet Delay Variation (IPDV)

In data networks, jitter refers to packet jitter, not bit jitter and represents the variation in a stream's delay (expressed in seconds). Jitter is the standard deviation of delay and is one of the IP performance metrics.

The jitter is the absolute value of the difference between the delay measurements of two packets belonging to the same stream. The jitter between two consecutive packets in a stream is reported as the "instantaneous jitter". Instantaneous jitter can be expressed as $|D(i+1) - D(i)|$ where D equals the delay and i is the test sequence number. Packets lost are not counted in the jitter measurement.

Jitter particularly affects the performance of real time network applications such as streaming video and audio. In these types of applications, data needs to arrive at a specific time frame or it becomes useless. As a result, many streaming audio and video application can be severely impacted by high jitter.

Latency (End-to-End Delay)

Latency is defined as the period of time it takes for the information element (voice, e-mail, web, etc.) to traverse the network from its origin to its destination. For basic data where a small delay can be tolerated, latency is usually not an issue. However, for communications services used for videoconferencing or VoIP for example, latency can interfere with the audio and/or visual communications. In shared bandwidth transmission environments, it is possible to encounter latency that varies dynamically, caused by perhaps a single user accessing or originating multi-megabyte-sized files or accessing high bandwidth streaming signals.

Network Errors

Generally, packet losses or corruptions are the source of the network errors:

- Main cases of packet loss:
 - Network load - which can cause a packet queue in a network hop to overflow. This will cause new packets to be dropped due to lack of memory space. This typically results in a burst loss where several packets from one endpoint are lost at once.

- Limited bandwidth - QoS parameters such as Frame Relay CIR (Committed Information Rate) or Diffserv bandwidth polices can define a data rate limit which, when exceeded, can result in dropped packets.
 - Congestion avoidance mechanisms, such as RED (Random Early Detection) implemented in network gateways and routers can selectively decode and drop packets in order to avoid what seems to be an upcoming congestion trend.
 - IP header corruption is an error that creates a malformed IP header. A malformed IP header will cause the next router receiving the corrupted packet to drop it.
 - Hardware faults such as link disconnections and device shutdown.
- Packet corruption: is caused by errors in the physical layer, which in turn causes data bits to toggle.

Packet Loss

Packet loss is a normal phenomenon on packet networks: when data transmitted from an originating device don't arrive at the intended destination. Loss can be caused by many different reasons: overloaded links, excessive collisions on a LAN, and physical media errors, to name a few. Transport layers such as TCP account for loss and allow packet recovery under reasonable loss conditions.

Propagation Delay

The propagation delay is the time required for a packet to travel over the network (difference between the transmission of data to its receipt at the other end).

Quality of Experience (QoE)

QoE means the overall acceptability of an application or service, as perceived subjectively by the end-user. Quality of Experience includes the complete end-to-end system effects (client, terminal, network, services infrastructure, etc.). And the overall acceptability may be influenced by user expectations and context.

Quality of Service (QoS)

A list of measurable attributes that should be met for a specific communications service on a network: bandwidth, latency, packet loss rate, out-of-sequence packet and latency variation (jitter) for real-time applications such as VoIP, and service availability.